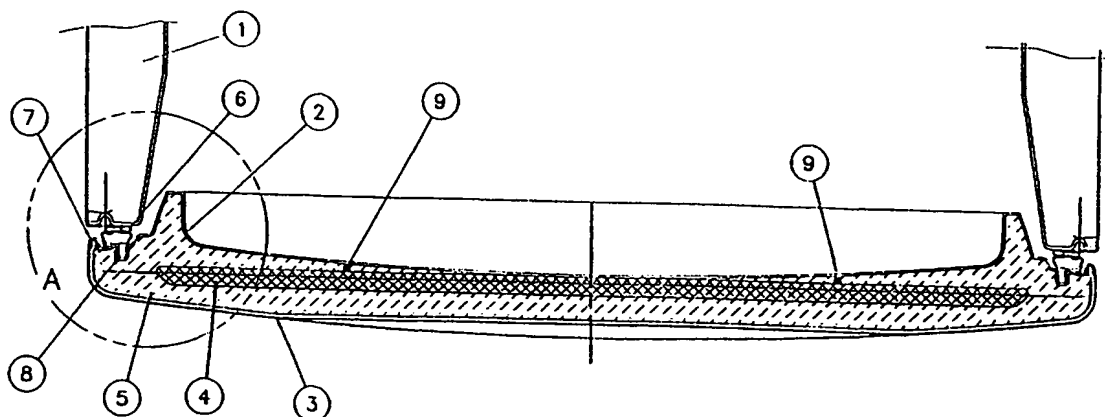


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>F25D 23/02, 23/06, 23/08</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 98/34077</b> <b>(43) International Publication Date:</b> 6 August 1998 (06.08.98)
<b>(21) International Application Number:</b> PCT/TR98/00004 <b>(22) International Filing Date:</b> 3 February 1998 (03.02.98) <b>(30) Priority Data:</b> 97/00083 3 February 1997 (03.02.97) TR <b>(71) Applicant (for all designated States except US):</b> ARÇELİK A.Ş. [TR/TR]; 81719 Tuzla, Istanbul (TR). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> ÖZKADI, Fatih [TR/TR]; Bahçelerarası Sokak Eminbey Apt. 41/3, 81110 Ataşehir, Istanbul (TR). YAVUZ, Nihat [TR/TR]; Ridvan Pasa Cad. Göl Sokak Kutlu Apt. 29/8, 81110 Göztepe, Istanbul (TR). ODABAS, Sibel [TR/TR]; Sinan Ercan Sokak No. 33/9, 81090 Kozyatagi, Istanbul (TR). <b>(74) Agent:</b> ANKARA PATENT BUREAU LTD.; Şehit Adem Yavuz Sokak 8/22, 06440 Kızılay Ankara (TR).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i>

**(54) Title:** REFRIGERATOR DOOR WITH AN ADVANCED INSULATION AND RE-CYCLING PERFORMANCE**(57) Abstract**

The present invention is related with a refrigerator door the inner and exterior faces of which are coated with plastic material and which does not contain polyurethane in its insulation system. In the refrigerator door according to the present invention that provides the insertion of a combined structure, prepared in advance in a mould assembly consisting of two materials, namely a vacuum insulation liner (4) and an expanded polystyrene (5), into the insulation gap between the plastic liners (2, 3) forming the inner and exterior surfaces; as the vacuum insulation liner has better insulating properties compared to polyurethane, it has been possible to reduce the insulation thickness and thus to enlarge the inner volume of the refrigerator. Due to the fact that no polyurethane has been used in the insulation system and since the selected materials can easily be disassembled, an insulation system which can be completely recycled after completing its service life, is obtained.

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**REFRIGERATOR DOOR WITH AN ADVANCED INSULATION  
AND RE-CYCLING PERFORMANCE**

- 10 The present invention is related to a refrigerator door inner and outer surfaces of which are plastic coated and which contains no polyurethane in its insulation system.

Refrigerators are cooling and/or freezing devices manufactured for the purpose of  
15 keeping food fresh. A refrigerator is desired to have as large an inner volume as possible and to consume little energy. Besides these, after completing their service lives easy decomposition and recycling properties of the parts and materials constituting the refrigerator, are quite important with regard to environment protection problems.

20

The major parameter for a refrigerator in order to have a large inner volume and to consume less energy, is its insulation system. From the insulation system of a refrigerator, the type and heat transfer coefficient of the insulating material, type and heat transfer coefficients of inner and outer lining materials of a refrigerator  
25 and insulating thickness of the walls of a refrigerator are easily understood.

In order to provide less consumption of energy, the heat gain of the refrigerator must be reduced as much as possible. This is provided by the improvement of the insulation system which can be achieved by increasing the insulation thicknesses  
30 of the presently used systems or by developing a new system with a lower heat transfer coefficient.

As the external dimensions particularly as depth and width the of the refrigerators are restricted by standards, reducing the thickness of insulated walls appears to be the only solution when inner volume is intended to be widened. In the known  
5 insulation systems, reducing the thickness of insulating walls, leads to an increase in the refrigerator heat gain, and therefore more energy consumption. In this case in order to meet optimally the wide inner volume and low energy consumption expectations, a more effective insulation system has to be used.

10 In addition to the above mentioned expectations, such properties as easy decomposability and recyclability with a relatively low cost of the material and components, are taken into consideration in the new insulation system. For this reason, at the design stage of a refrigerator, recycling and re-usage possibilities have to be considered and reflected to the design.

15

In the insulation systems of the existing refrigerators, steel sheet, thermoplastic material [polystyrene (PS) or acrylonitrile butadiene styrene (ABS)] and as insulation material polyurethane, are commonly used.

20 Steel sheet is used to form the outer surface of refrigerator cabin and doors, whereas the inner surface are lined with thermoplastic material. Polyurethane is used to fill the space between inner and outer liners.

When liquid polyurethane, obtained by mixing poliol, isocyanate and a blowing  
25 agent in given proportions, is injected into the insulation space, it takes the form of a foam that adheres both to the steel sheet as the outer lining material and to the plastic being the inner lining material. As it also adheres to the door gasket, it helps the fixation of the gasket in the system. By means of this adherence, in general, a strong structure for the refrigerator is obtained. However, since  
30 polyurethane is a thermoset material, it cannot be recycled. Furthermore, as it adheres to the steel sheet and to the plastic, after the service-life is completed it

causes difficulties in decomposition of these components during disassembly and increases the cost of this operation.

5 The above mentioned existing insulation systems and the combined structure of the materials used in these systems make the recycling process very difficult, even impossible. In addition, by these systems it is not possible to obtain a wider inner volume with constant external dimensions and to provide less energy consumption without modifying the existing cooling system.

10 As giving a steel sheet the desired form is quite difficult and expensive, its use as outer lining requires some processes for aesthetic purpose and restricts the design freedom.

15 There are some studies proposing the use of plastics in manufacturing refrigerators, particularly refrigerator doors. In the US Patent No. 5.533.311, a unitary plastic refrigerator door made by thermoforming an outer refrigerator door liner with an inner refrigerator door liner. The inner plastic liner is designed so that it press-fittingly receives the door gasket designed previously and the inner plastic is attached to the outer plastic door liner. Into an internal chamber  
20 (space) defined between the outer door liner and inner door liner a foam is injected. No explanatory technical details about this foam are given in the said document.

25 The Japan patent No. 8.189.755, discloses that the exterior of the refrigerator door is made of thermoplastic resin and the inner part of it, from plastic. Inner and outer plastic liners are attached to each other by means of a specific profile and the gasket is held in the system also by means of this profile. The space defined between these two liners is filled with a heat insulator. No detailed information was given in the said document. On the exterior side of the  
30 refrigerator, the profile is provided with a decorative sheath at the edge.

In the US Patent No 5 306 082, an "all plastic refrigerator" manufactured by blow moulding process is mentioned. Some structural shelf-like forms are created by the help of the recesses formed inside the inner door member, for the purpose of storing food. Inside the insulation space such non-rigid insulating material as, blown foam element and weak fiberglass particules are filled.

The above mentioned patents do not bring a new proposal with regard to insulation systems, although they provide the inner and outer sides of the refrigerator door to be formed by using plastic.

10

The main object of the present invention is to reduce the insulation thickness by providing a new insulation system with a different and better insulating performance as compared with the existing insulation systems and in association with it, to provide a refrigerator with wider inner volume that consumes less energy.

15

Another object of the invention is to realize a refrigerator inner and outer materials of which are of plastic, which contain no polyurethane and which can be completely recycled. Due to the advantages of using plastic material, realizing practices related to external appearance, i.e. aesthetic considerations and providing elasticity and freedom in design are among the other objects of the present invention.

20

A preferred embodiment of a high insulation and recycling performance refrigerator realized to achieve these objects is illustrated in the attached drawings, wherein:

25

Figure 1, is the cross-section view of the refrigerator door;

Figure 2, is the section view of detail A shown in Fig.1.

30

The corresponding component reference numbers are as follows;

- 1) Refrigerator cabinet
- 5    2) Inner plastic liner
- 3) Outer plastic liner
- 4) Vacuum insulation liner (VIP)
- 10    5) Expanded polystyrene (EPS)
- 6) Gasket
- 15    7) Plastic decorative cover
- 8) Gasket recess
- 9) Mould support element

20

In the refrigerator according to the present invention, a plastic liner (2) constitutes the inner surface of the door. This liner (2) is formed by vacuum thermoforming process. A gasket (6) used to provide the insulation between the refrigerator door and cabinet (1) is fit into a gasket recess (8) designed on the surface of the inner plastic liner (2) and its profile is shown in detail in Figure 2. The outer surface of the door is lined by a plastic liner (3) which is advantageously made by a thermoforming process enabling the designers to give the desired aesthetic appearance.

- 30    For the insulation system of the said refrigerator door of the present invention, a combined structure consisting of vacuum insulation liner (VIP) (4) and expanded

polystyrene (EPS) (5) is used instead of polyurethane. This structure is prepared so that it fills the space defined between the inner and outer plastic liners (2 and 3) by being placed into a mould assembly consisting of male and female mould elements. After closing the moulds in such a manner that they receive the  
5 vacuum insulation liner (4), expanded polystyrene granules are injected into the space defined between them and subjected to steam process. After injection all VIP is left within the expanded polystyrene thus providing the two materials to constitute a combined structure. During polystyrene injection, the moulds are placed horizontally by means of the mould supporting elements (9). It is also  
10 possible to place said moulds vertically.

Then, the above described combined structure is located between the inner and outer plastic liner (2 and 3).

15 These plastic liners are joined to each other, according to the principle of melting the plastics and welding them together by strongly pressing on each other, by using such methods as ultrasonic welding, vibration-welding etc. at their contact points. After the completion of all joining and assembly processes, the joining seam is covered by a plastic decorative sheath (7) to provide an  
20 aesthetic appearance.

This insulation system can easily be disassembled and decomposed at the end of its usage life. As expanded polystyrene does not adhere to the inner and outer plastic liners, the said plastic liners may be recycled and put in the form of  
25 granules. Moreover, polystyrene is also a thermoplastic based material such as the said plastic liners and can be recycled, just like the VIPs which can be re-used unless deformed by any impact. Consequently, a VIP that can be taken out of an old refrigerator, may be used for the insulation system of another refrigerator.

30



Although the preferred embodiment of the present invention is disclosed for a refrigerator door, the above mentioned combined structure may be used also for the walls of refrigerator cabinets.

## CLAIMS

5

1. A refrigerator door wherein its inner and outer surfaces are lined with plastic material, characterized in that the vacuum insulation liner (4) is placed horizontally or vertically into a mould assembly consisting of male and female mould units, by means of mould support elements (9); after closing  
10 the moulds in such a manner that they contain the vacuum insulation liner (4), expanded polystyrene granules are injected into the gap defined between two moulds and are subjected to steam fusing; following the injection process the vacuum insulation liner is completely left within expanded polystyrene in order to form a combined structure consisting of these two materials and this  
15 combined structure is placed between the inner and outer plastic liners.

2. A refrigerator with high insulation and recycling performance according to claim 1, characterized in that said combined structure is used as the  
20 insulation material between the inner and outer surfaces of the refrigerator cabinet walls.

25

30

1/2

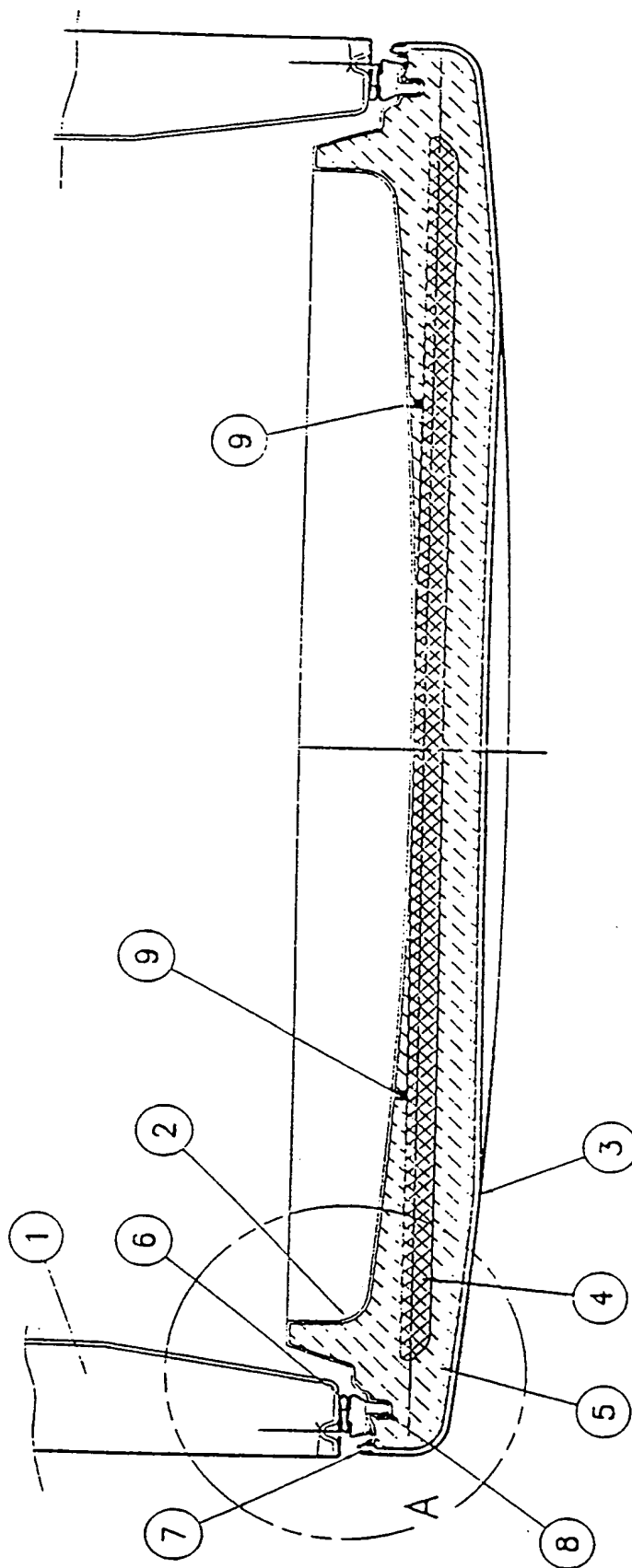


FIG. 1

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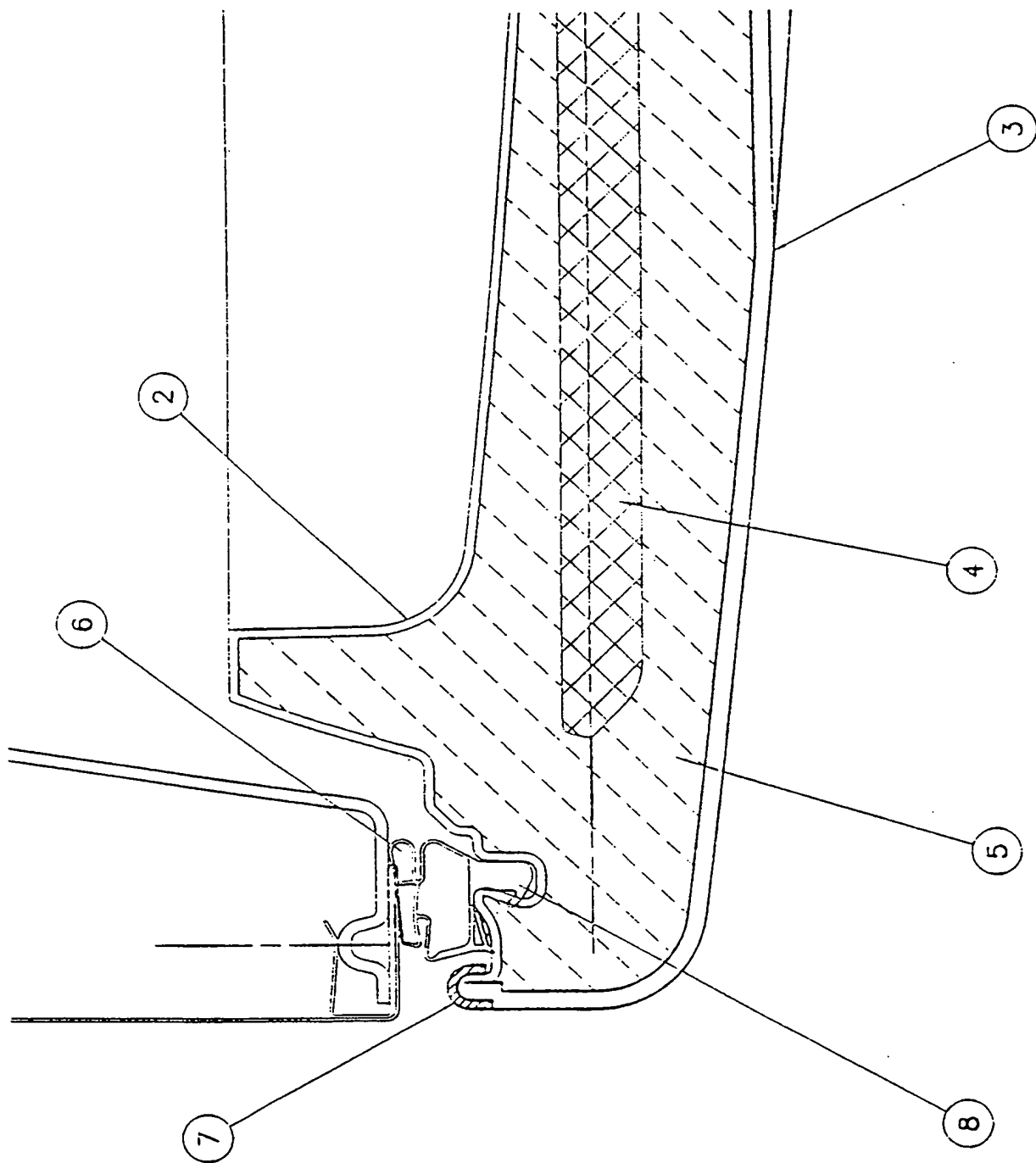


FIG. 2

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/TR 98/00004

## A. CLASSIFICATION OF SUBJECT MATTER

IPC<sup>6</sup>: F 25 D 23/02, 23/06, 23/08

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IPC<sup>6</sup>: F 25 D; E 06 B

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0 747 646 A1 (DEVI) 11 December 1996 (11.12.96), totality.	1,2
A	US 5 533 311 A (TIRRELL) 09 July 1996 (09.07.96), column 9, lines 13-31 (cited in the application).	1,2
A	JP 56-015 342 A2 (SEKP) 14 February 1981 (14.02.81), totality.	1,2
P,A	WO 97/12 100 A1 (OWENS CORNING) 03 April 1997 (03.04.97), totality.	1,2
A	US 5 418 055 A (CHEN) 23 May 1995 (23.05.95), claims.	1,2
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09 June 1998 (09.06.98)

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